Machine Learning Exercises 2

Due: October 4

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October 3, 2007

Exercises

1. Consider the LIST-THEN-ELIMINATE algorithm for the EnjoySport example with hypothesis space

$$\mathcal{H} = \{\langle ?, ?, ?, ?, ?, ? \rangle, \langle \text{Sunny}, ?, ?, ?, ?, ? \rangle, \\ \langle \text{Cloudy}, ?, ?, ?, ?, ? \rangle, \ldots, \langle \emptyset, \emptyset, \emptyset, \emptyset, \emptyset, \emptyset \rangle\},$$

as described on slide 19 of `mlslides3.pdf`. Please give an example of a hypothesis (i.e. a function from feature vectors to class labels) that is not contained in $\mathcal{H}$.

2. Suppose we are given the data in Table 1. Consider the LIST-THEN-ELIMINATE algorithm with the hypothesis space $\mathcal{H}$ consisting of all possible **decision trees** for the EnjoySport domain. Given the data in the top three rows of the table, how would this algorithm classify the last example in the table, where there is a '?' instead of the label?

Table 1: EnjoySport Data

x						y
Sky	**AirTemp**	**Humidity**	**Wind**	**Water**	**Forecast**	**EnjoySport**
Sunny	Warm	Normal	Strong	Warm	Same	Yes
Sunny	Warm	High	Strong	Warm	Same	Yes
Rainy	Cold	High	Strong	Warm	Change	No
Sunny	Warm	High	Strong	Cool	Change	?

3. [This is Exercise 3.1 from Mitchell.] Consider classification of data in which the 4-dimensional feature vector $\mathbf{x}$ contains four Boolean features: A, B, C and D. (Boolean means that a feature can only take two possible values: 0 and 1, which we may think of as 'False' and 'True', respectively.) Furthermore, the class label y is also Boolean. Give decision trees to represent the following Boolean functions[1]:

   (a) $y = A \wedge \neg B$

   (b) $y = A \vee (B \wedge C)$

[1] I suggest that you draw these trees in some drawing program like, for example, Photoshop (on Windows) or the Gimp, Inkscape, or Xfig (on Linux). It is okay if your trees don't look pretty, but they should be readable without too much effort.

(c) $y = A \otimes B$

(d) $y = (A \wedge B) \vee (C \wedge D)$

The symbol '$\otimes$' denotes the **exclusive or** of its arguments. Its truth table is in Table 2.

Table 2: Truth table of exclusive or.

A	B	$A \otimes B$
0	0	0
0	1	1
1	0	1
1	1	0

4. Suppose that $\Omega = \{\omega_1, \ldots, \omega_k\}$ is a sample space and that p and q are both probability mass functions on Ω. Let P and Q denote the probability distributions on Ω that are defined by p and q, respectively. Show that if $p \neq q$, then $P \neq Q$.

Grading Policy

- Grades are between 1 and 10.
- You always start with 1 point.
- Partial points may be awarded for partially correct exercises.